

## DATA TRANSMISSION METHOD AND APPARATUS

### TECHNICAL FIELD

**[0001]** The present disclosure relates to wireless communication systems, and particularly to a method and apparatus for configuring a channel state information reference signal (CSI-RS), measuring channel state information (CSI) and configuring a de-modulation reference signal (DMRS).

### BACKGROUND ART

**[0002]** In 3rd generation project partnership (3GPP) long term evolution (LTE) systems, each radio frame has a length of 10 ms and is equally divided into 10 subframes. As shown in FIG. 1, taking a frequency division duplexing (FDD) system as an example, each radio frame has a length of 10 ms, and includes 10 subframes. Each subframe has a length of 1 ms, and is composed of two consecutive time slots, i.e., the  $k$ 'th subframe includes time slot  $2k$  and time slot  $2k+1$ ,  $k=0, 1, \dots, 9$ . Each time slot has a length of 0.5 ms. A downlink transmission time interval (TTI) is defined in a subframe.

**[0003]** FIG. 2 is a schematic diagram illustrating a downlink subframe in an LTE system. As shown in FIG. 2, the preceding  $n$  orthogonal frequency division multiplexing (OFDM) symbols ( $n$  is 1, 2 or 3) are a downlink control channel region for transporting downlink control information of users. Downlink control channels include physical control format indicator channel (PCFICH), physical hybrid automatic repeat request (HARQ) indicator channel (PHICH) and physical downlink control channel (PDCCH). Remaining OFDM symbols are used for transporting physical downlink shared channel (PDSCH) and enhanced PDCCH (EPDCCH). Downlink physical channels are a collection of resource elements. A resource element (RE) is the smallest unit of time/frequency resources. RE is a subcarrier in frequency domain and an OFDM symbol in time domain. The granularity of physical resource allocation is physical resource block (PRB). A PRB includes 12 consecutive subcarriers in frequency domain, and corresponds to a time slot in time domain. Two PRBs within two time slots on the same subcarriers in a subframe are referred to as a PRB pair. Different REs may have different usages, e.g., cell-specific reference signal (CRS), user-specific DMRS and channel state information reference signal (CSI-RS). In a subframe, at most 40 REs may be used for CSI-RS transmission, and a base station may configure some or all of the REs to be used for CSI-RS transmission.

**[0004]** The number of CSI-RS ports may be configured to be 1, 2, 4, or 8 according to the number of antennas deployed by the base station. As shown in FIG. 3, when one or two CSI-RS ports are configured, CSI-RS is transported in two REs on the same subcarrier of two adjacent OFDM symbols. When four CSI-RS ports are configured, CSI-RS is transported in four REs located in two adjacent OFDM symbols and two subcarriers. When eight CSI-RS ports are configured, CSI-RS is transported in eight REs which are mapped onto four subcarriers of two adjacent OFDM symbols.

**[0005]** Information that needs to be specified may include the periodicity, the subframe offset of CSI-RS and REs in a subframe, to identify time/frequency resources on which the CSI-RS resources are mapped. As shown in Table 1, CSI-RS subframe configuration is used for identifying the position in

a subframe occupied by CSI-RS, i.e., indicating the periodicity  $T_{CSI-RS}$  and the subframe offset  $\Delta_{CSI-RS}$  of CSI-RS. Specifically, subframes for CSI-RS transmission satisfy  $(10n_f + \lfloor n_s/2 \rfloor - \Delta_{CSI-RS}) \bmod T_{CSI-RS} = 0$ , where  $n_f$  is the system frame number,  $n_s$  is the time slot ID in a frame.

TABLE 1

Table 1: CSI RS subframe configuration		
CSI RS subframe configuration	CSI RS periodicity $T_{CSI-RS}$	CSI RS subframe offset $\Delta_{CSI-RS}$
0-4	5	$I_{CSI-RS}$
5-14	10	$I_{CSI-RS} - 5$
15-34	20	$I_{CSI-RS} - 15$
35-74	40	$I_{CSI-RS} - 35$
75-154	80	$I_{CSI-RS} - 75$

**[0006]** Table 2 shows REs onto which each CSI-RS configuration is mapped. In a PRB pair, REs corresponding to CSI-RS port 15 in CSI-RS configuration are determined by a two-tuple ( $k'$ ,  $l'$ ) according to the number of CSI-RS ports, wherein  $k'$  is a subcarrier index in the PRBs,  $l'$  is an index of an OFDM symbol in a time slot.

**[0007]** According to LTE standards, when one or two CSI-RS ports are configured, it may be regarded that the power of CSI-RS REs is normalized because each antenna may transmit downlink signals in all REs in an OFDM symbol. When four CSI-RS ports are configured, preceding 2 CSI-RS ports and last 2 CSI-RS ports are transmitted in different subcarriers respectively, which results in that the power of each CSI-RS port may be doubled, i.e., increased by 3 dB. When eight CSI-RS ports are configured, every two CSI-RS ports occupy one subcarrier, and do not transmit any signal in subcarriers of other CSI-RS ports, so that the power of each CSI-RS port may be quadrupled, i.e., increased by 6 dB.

**[0008]** Based on the above CSI-RS structure, conventional LTE systems may support downlink data transmission using 8 antenna ports. As shown in FIG. 4, antennas are generally deployed as a one-dimensional antenna array in the horizontal direction, and are made to direct at different horizontal angles via beamforming. Terminals may be located at different positions in the vertical direction and may be at different distances from the base station, and thus correspond to different vertical angles. In subsequent enhanced LTE systems, each cell may be configured with 16, 32, 64 or more transmitting antennas to make use of the gain of spatial multiplexing, increase cell throughput and reduce inter-user interferences. As shown in FIG. 5, beamforming in the vertical direction and beamforming in the horizontal direction may be applied to a two-dimensional antenna array to further reduce interference between terminals corresponding to different vertical direction angles and between terminals corresponding to different horizontal direction angles.

**[0009]** As such, cell throughput can be further increased, as shown in FIG. 6.

**[0010]** For systems configured with more than 8 physical antennas, e.g., the two-dimensional antenna array as shown in FIG. 5, proper methods are needed to process multi-user multiple input multiple output (MU-MIMO) transmission and CSI measurement and feedback. The more physical antennas configured, the narrower beams can be generated, and more user equipments (UEs) can be multiplexed using MU-MIMO techniques. A to-be-solved problem is how to